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1.0
2.8
2.5
3.2
2.2
3.6
4.0
2.0
1.1
1.8
1.25
1.4
1.6

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12

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EVALUATION OF "SORBOTHANE" CUSHIONING MATERIAL

HQ AFLC/DSTZ
AIR FORCE PACKAGING EVALUATION AGENCY
Wright-Patterson AFB OH 45433

January 1984

NOTICE

AFPEA PROJECT NO.: 82-P7-94
PROJECT TITLE: Evaluation of Sorbothane
PROJECT MONITOR: M. Wyderski

ABSTRACT

"Sorbothane", a high density polyurethane material with unusual displacement properties, is presently used extensively as a cushioning material for the human body in medical and sporting applications. This study was undertaken to consider possible packaging applications for this unique material in providing cushioning and shock isolation for Air Force equipment.

Various structural configurations of the material were subjected to dynamic cushioning evaluation. In addition the material was evaluated for its shear strength characteristics for possible use in shear mount type shock isolators.

Results of this evaluation indicate that dynamic cushioning characteristics of Sorbothane are only slightly better than some commonly used materials. The high density and cost of Sorbothane makes this material quite impractical as a cushioning material in comparison with the commonly used materials. The low shear strength of Sorbothane and its tendency to tear under shear loading makes it unsuitable for use in shock isolators.

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INTRODUCTION

Sorbothane, a high density polyurethane material with unusual displacement properties, is currently being marketed as a cushioning material for the human body in medical and sporting applications. Possible applications of this material in Air Force packaging were investigated by this agency. Its use as a package cushioning material and as the main component in shock isolator devices was considered.

MATERIAL DESCRIPTION

Sorbothane was developed in Great Britain by material scientists and orthopedic surgeons to reduce heel impact shock waves and, as a result, eliminate various neuroskeletal disorders such as arthritis, rheumatism, and backaches.

Sorbothane has a unique structure produced by the modification of a polyol-isocyanate reaction that results in a high percentage of short chain structures. The result is a material which has a dough-like texture though it retains permanent and measurable dimensions.

Some of the properties of Sorbothane are as follows:

1. Absorbs mechanical, acoustic and electromagnetic energy.
2. Sensitive to frequency of energy impulse.
3. Distorts readily, recovery slow-but controllable.
4. Compression set negligible.
5. Effective between -400°F and +230°F.
6. Fire retardant.
7. Liquid absorption, (including petroleum products), is negligible.
8. Inert to environmental attack.
9. Density normally 83.6 lb/ft^3, but can be foamed to reduce the density to about 18.7 lb/ft^3.

TEST SPECIMENS

Four different configurations were subjected to dynamic cushioning evaluation. These configurations are illustrated in Figure 1. Configuration No. 1 was a solid block of Sorbothane with dimensions, 2 3/4" x 2 3/4" x 2". Configuration No's 2 and 3 each consisted of four small blocks of Sorbothane bonded to the corners of an 8" x 8" piece of solid fiberboard. Configuration No. 4 consisted of polyurethane foam strips bonded to Sorbothane strips.

Shear strength tests were conducted on specimens measuring 1 7/16" x 7/8" x 1" and 5" x 13/16" x 1". The shear stress was applied across the one-inch thickness of the specimens.

TEST EQUIPMENT AND INSTRUMENTATION

The following test equipment and instrumentation were used to conduct this study:

1. Hardigg Cushion Tester, Hardigg Industries Inc., Model No. 3.
2. Oscilloscope, 4 channel storage, Tektronix Model 564-B.
3. Accelerometer, Statham Model A5-100-350.
4. Amplifier, Sensotec Model RM-6.
5. Energy Computer, EC700, GHI Systems, Serial No. 90809.

TEST PROCEDURES

Dynamic Cushioning Test

The various configurations (see Figure 1) were subjected to dynamic cushioning evaluation in accordance with ASTM Standard D1596, "Shock Absorbing Characteristics of Package Cushioning Materials". Drop heights of 12", 18" and 24" were used. Static stress loads were varied at each drop height. Five drops were made on each sample at each static stress load with allowance of one minute between drops to allow for specimen recovery. The last four peak acceleration values recorded for each set of five drops were averaged and the average values were plotted in the form of peak acceleration (G's) vs static stress curves.

Shear Strength Test

Two samples were tested for shear strength. Each sample was bonded between two metal plates, as shown in Figure 2. One plate was suspended from a fixed support while the other plate was loaded by attaching a can containing weights to its lower edge. Deflection was measured from the top edge of the loaded plate with reference to the adjacent fixed plate at 24 hour intervals; additional weight increments were added after each 24 hour interval.

RESULTS/DISCUSSION

Dynamic Cushioning

Results are shown in Figures 3-7. Figure 3 indicates that Sorbothane has cushioning properties similar to polyethylene foam of 6 lb/ft^3 for static stress loads less than 4.0 psi. At static stress loads greater than 7.9 psi, Sorbothane is slightly better than polyethylene of 9.0 lb/ft^3 density.

Figure 4 indicates that Configuration 1 provided the most favorable dynamic cushioning properties. The effective bearing area of the Sorbothane material of Configurations 2, 3 and 4 was used to determine the static stress loads in this figure. The Sorbothane in Configurations 2, 3 and 4 was arranged to provide a greater effective loading base area in an attempt to eliminate the buckling effect noted during the evaluation of Configuration 1. However,

all of these configurations still gave evidence of buckling.

Compared with polyethylene, 4 lb/ft^3 density, the combination sample of alternating polyurethane foam and Sorbothane strips (Configuration 4), indicated somewhat similar, though more favorable cushioning characteristics (see Figures 5 and 6).

Shear Strength

Results for shear strength test specimen #1 are shown in Table I and Figure 7. The test specimen tore at four locations on the top surface after application of 12.8 lbs for a period of 24 hours. All four tears were located within 1/4" from the fixed plate. These tears were 3/8" - 3/4" in length and approximately 1/8" in depth. After the load was increased to 14.9 lbs for an additional 8 hours, three of the tears increased to 3/4" in length and the test was terminated. Specimen No. 2, after being subjected to 2.3 lbs for 24 hours, tore along the entire length of the top surface of the sample within 1/32" of the fixed plate.

CONCLUSIONS

Based on the results of this evaluation, it was concluded that it would not be feasible to consider Sorbothane for use as a cushioning material in package designs or as a shock isolator. Although the dynamic cushioning characteristics of Sorbothane were slightly better than comparable commonly used cushioning materials, Sorbothane is significantly higher in both cost and density. The tearing of this material under light shear loads precludes its use in shear mounts.

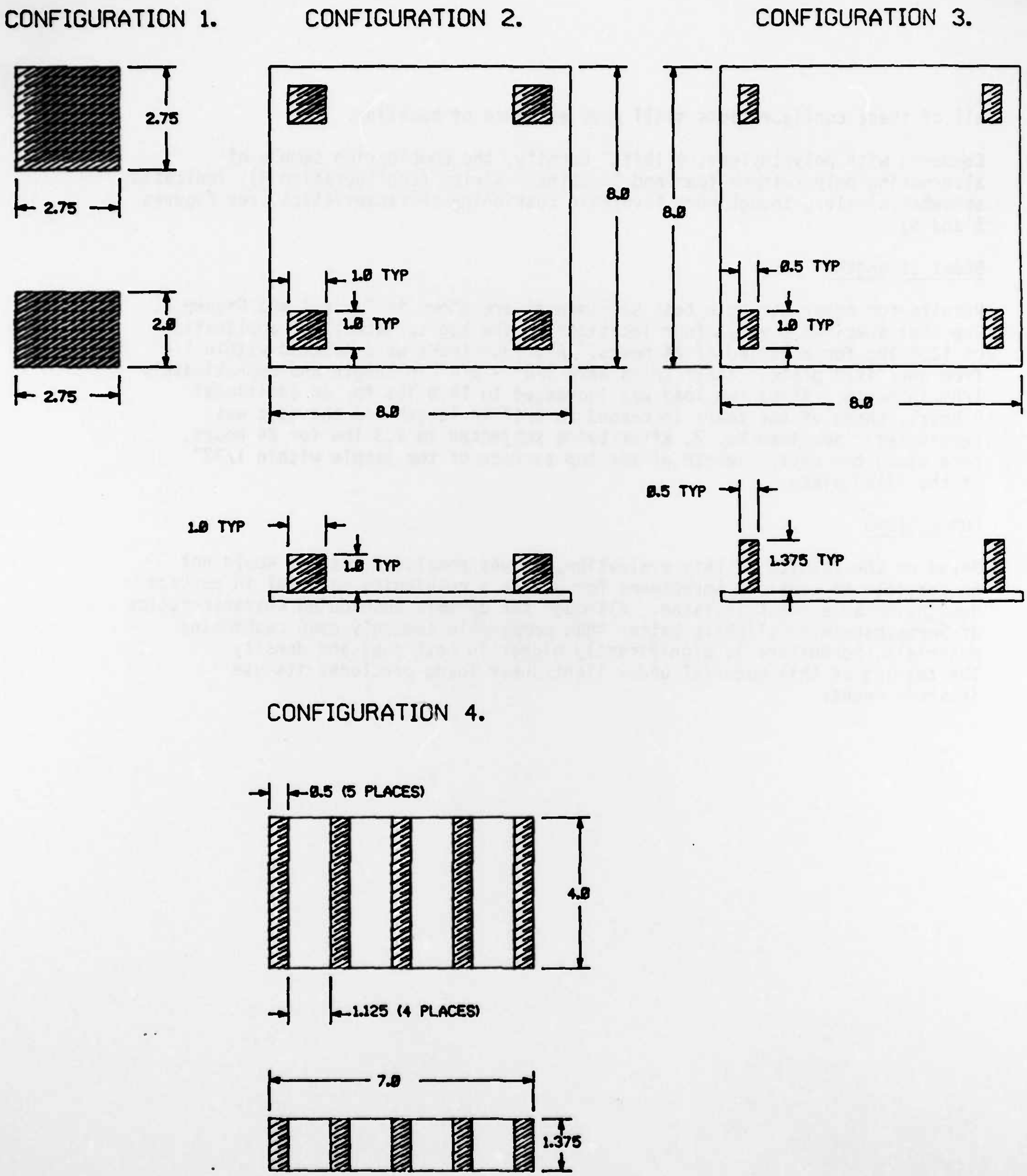
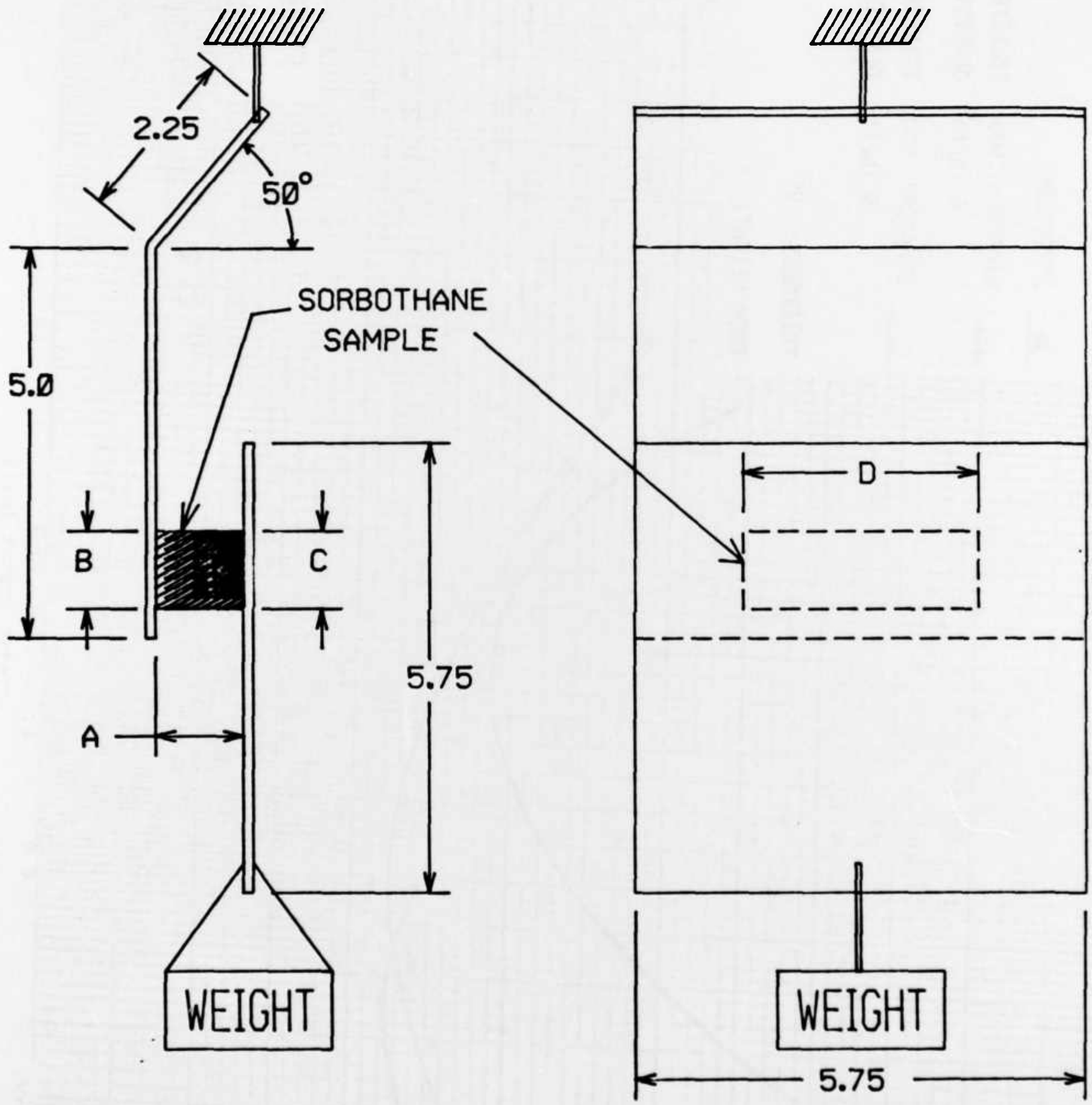


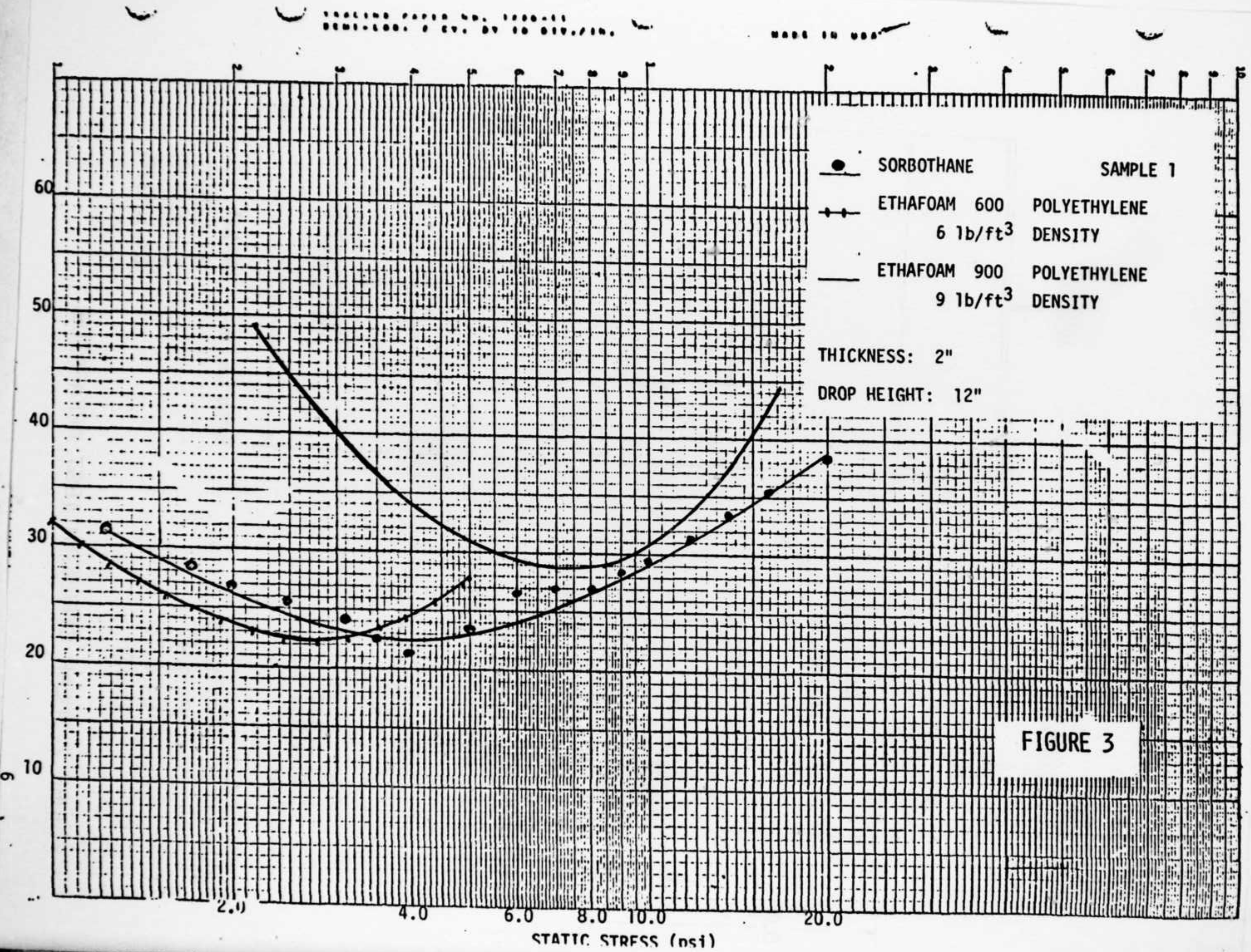
FIGURE 1 - DYNAMIC CUSHION TEST CONFIGURATIONS.



SAMPLE 1. A= 1.125
B= 1.Ø
C= Ø.75
D=5.Ø

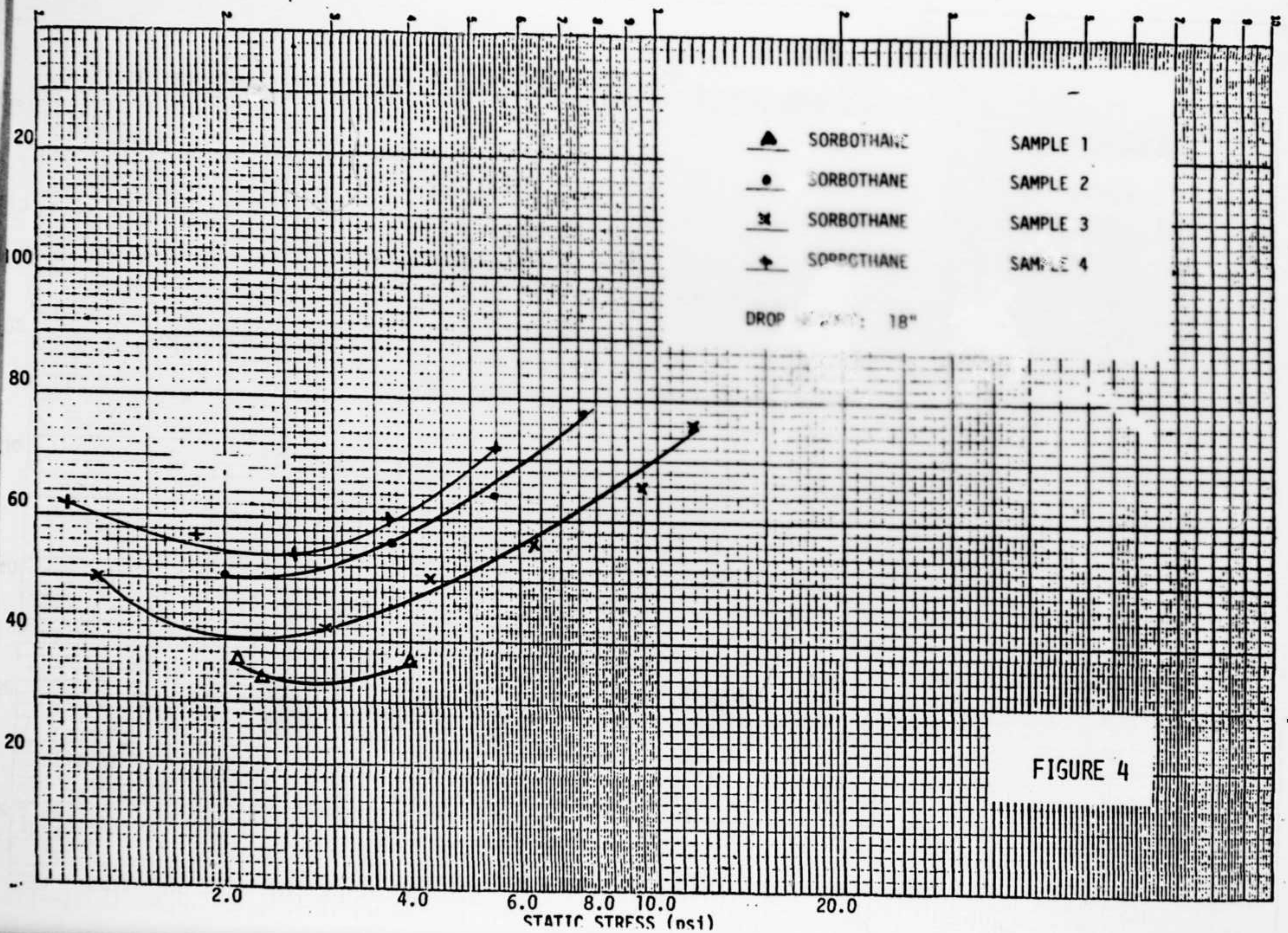
SAMPLE 2. A=1.Ø
B= 1.8125
C= Ø.8125
D= 1.4375

FIGURE 2. SHEAR STRENGTH TEST APPARATUS.



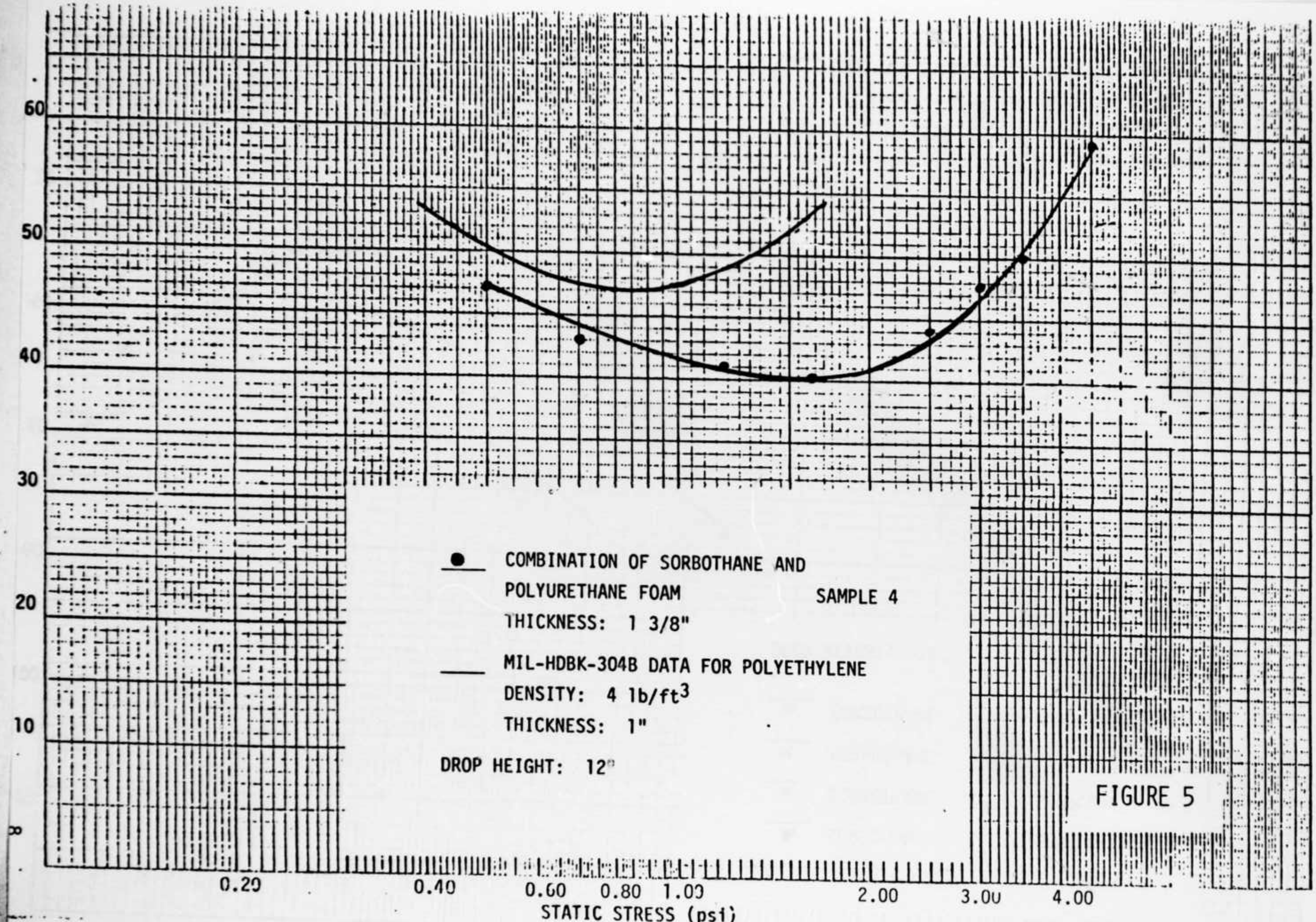
SORBOTHANE
SAMPLE 1
ETHAFOAM 600 POLYETHYLENE
6 lb/ft³ DENSITY
ETHAFOAM 900 POLYETHYLENE
9 lb/ft³ DENSITY
THICKNESS: 2"
DROP HEIGHT: 12"
60
50
40
30
20
10
2.0
4.0
6.0
8.0
10.0
20.0
STATIC STRESS (psi)

FIGURE 3



20
100
80
60
40
20
2.0
4.0
6.0
8.0
10.0
20.0
STATIC STRESS (psi)
SORBOTHANE SAMPLE 1
SORBOTHANE SAMPLE 2
SORBOTHANE SAMPLE 3
SORBOTHANE SAMPLE 4
DROP 18"

FIGURE 4



60
50
40
30
20
10
0.20
0.40
0.60
0.80
1.00
2.00
3.00
4.00
STATIC STRESS (psi)
COMBINATION OF SORBOTHANE AND
POLYURETHANE FOAM
SAMPLE 4
THICKNESS: 1 3/8"
MIL-HDBK-304B DATA FOR POLYETHYLENE
DENSITY: 4 lb/ft3
THICKNESS: 1"
DROP HEIGHT: 12"

FIGURE 5

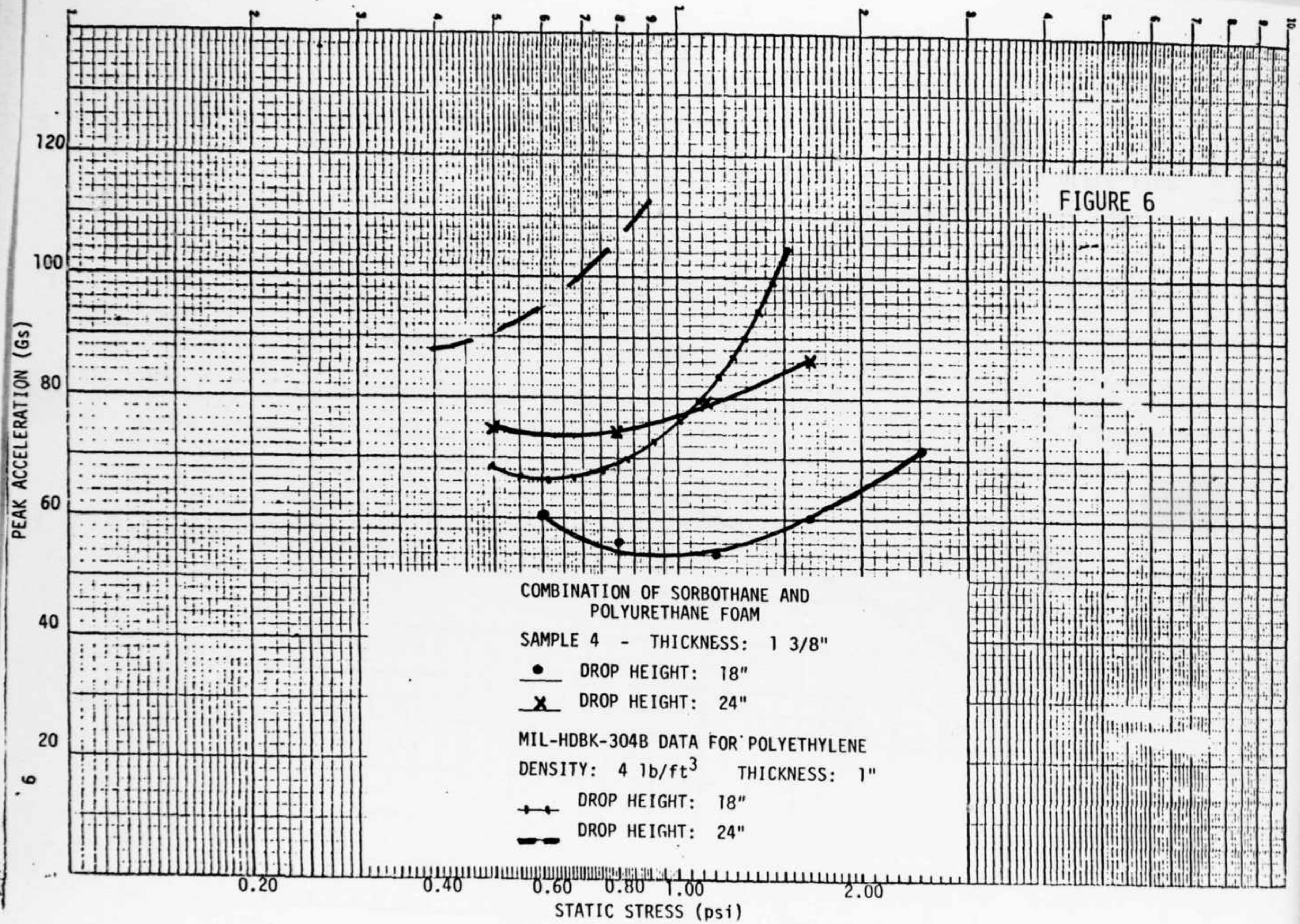


FIGURE 6
COMBINATION OF SORBOTHANE AND POLYURETHANE FOAM
SAMPLE 4 - THICKNESS: 1 3/8"
DROP HEIGHT: 18"
DROP HEIGHT: 24"
MIL-HDBK-304B DATA FOR POLYETHYLENE
DENSITY: 4 lb/ft^3 THICKNESS: 1"
DROP HEIGHT: 18"
DROP HEIGHT: 24"
PEAK ACCELERATION (Gs)
120
100
80
60
40
20
0.20
0.40
0.60
0.80
1.00
2.00
STATIC STRESS (psi)

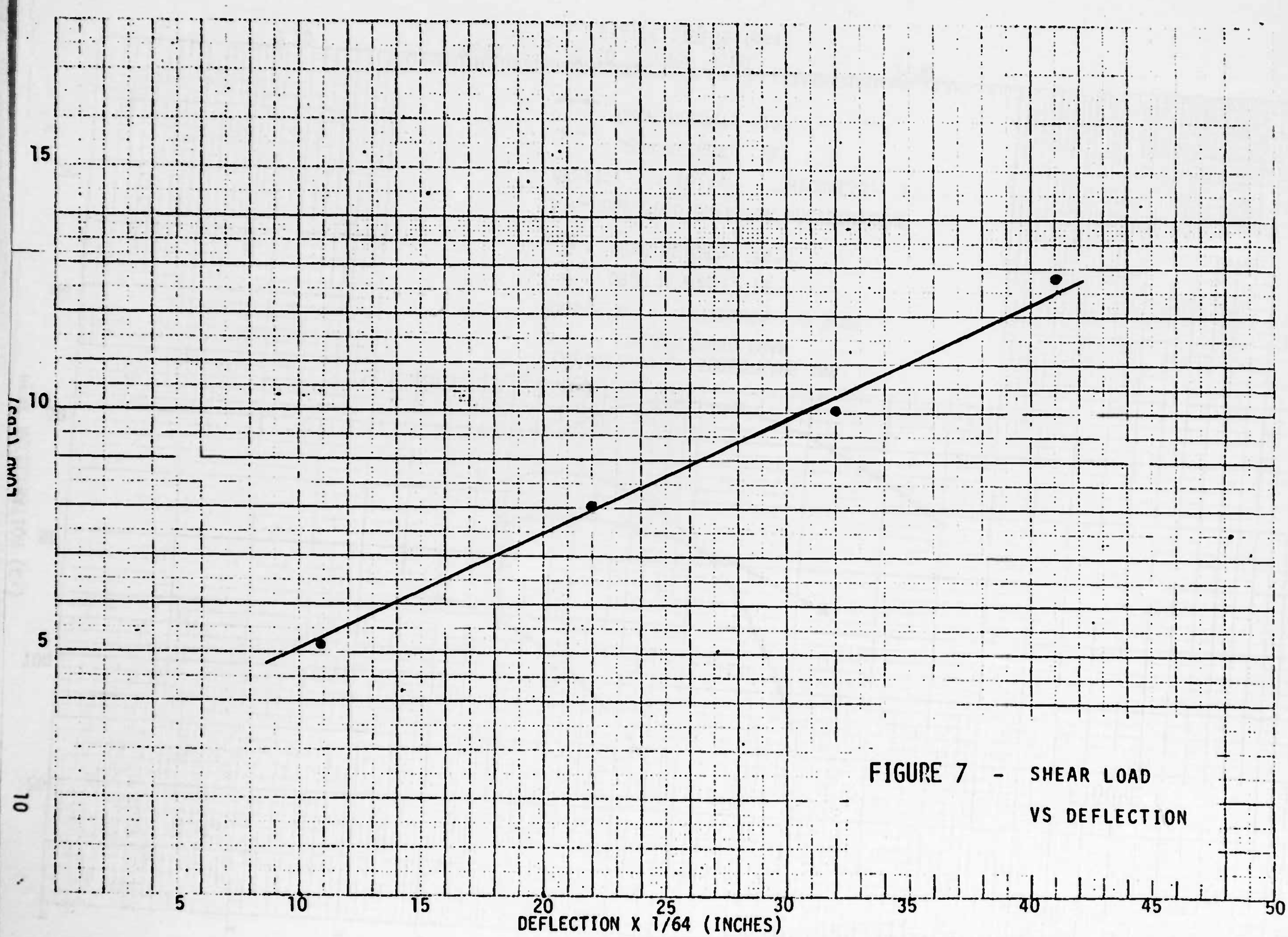


FIGURE 7 - SHEAR LOAD VS DEFLECTION

TABLE I - SHEAR STRENGTH TEST RESULTS FOR SPECIMEN 1

TOTAL LOAD APPLIED (LBS)	TIME PERIOD OF LOAD APPLICATION (HOURS)	INCREMENTAL DEFLECTION OF LOADED PLATE (INCHES)	TOTAL DEFLECTION OF LOADED PLATE (INCHES)
5.1	21.9	6/32"	6/32"
7.9	24.4	5/32"	11/32"
9.9	23.85	5/32"	16/32"
12.8	24.17	9/65"	41/64"

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